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OPERATING - MAINTENANCE INSTRUCTIONS

FOR

CACHE MARKER DETECTOR

TSS-PRO-4

13 JULY 1954

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I Operating Instructions

1. To place the detector in the operating condition:

a. Open the carrying case and lower the detector coil to the vertical position.

b. Pull out the operating handle which is located on the top of the metal box.

c. Hold the detector by the operating handle in such a way that the carrying case opens away from the operator.

d. Rotate the band switch to the proper band and set the main turning control to the proper setting. These settings will be known before starting the search.

e. Turn on the detector by pushing the two toggle switches which are located near the handle.

f. Plug in the phones.

2. Make the following initial adjustments:

a. Hold the detector about 8 inches from the operator's body and the same distance above the ground.

b. Rotate the amplitude control to approximately half way between its maximum and minium settings.

c. Rotate the fine tuning control ~~unit~~ until an audio tone is heard. The presence of the audio tone is an indication that the detector is operating properly. If not heard, increase the setting of the amplitude control slightly and re-adjust the fine tuning control

d. Now adjust the fine tuning control to a position so that the main tuning control can be rocked through about five divisions

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on either side of its prescribed setting without the audio tone dropping out.

e. Now back off the amplitude control until the audio tone can just be heard. This is the condition for maximum sensitivity. Make sure the main tuning control can still be rocked without the audio tone dropping out.

3. Make the search:

a. Listen for a null in the audio signal. This is an indication of the presence of the transponder. A null can also occur if the detector becomes mis-tuned due to bringing it too close to the ground or to the operator. A true indication is determined by rocking the main tuning control through the known transponder setting and verifying that the null occurs only when this control is on the proper setting.

b. During the search carry the detector so that it forms about a 30 degree angle with the direction in which the operator is walking.

c. Cover the area in which the transponder is believed to be located by marching along paths not over 12 feet apart. Decrease this distance by about two feet for each foot the detector is raised above the ground due to deep snow or other causes.

4. Determine the exact location of the transponder:

a. Place the detector coil in the horizontal position.

b. Repeat the initial adjustments, paragraph 2 above.

c. Approach the position of the transponder and while doing so reduce the sensitivity of the detector by turning up the amplitude control. This will reduce the area in which a null can be heard and thus more accurately locate the transponder.

5. To place the detector in the carrying condition:

a. Push in the operating handle. This will push the toggle switches to the off position.

b. Unplug the phones and place in the carrying case.

c. Close the carrying case.

6. To place a transponder with a cache:

a. Cover the cache with not less than one foot of earth.

b. Place transponder in the hole so that it is parallel to the surface of the ground (or water).

c. Cover transponder with at least one foot of earth.

d. Bring the detector near the transponder and find the exact setting of the band switch and main tuning control for the null. Record this setting for future use.

e. Finish filling the hole.

The frequency of each transponder will be marked on it. This frequency will change when it is buried. The change will always lower the frequency from 0.2 to 0.5 kilocycles depending upon conditions. Thus a future search can be expedited if the frequency is carefully measured when the cache is made. A calibration curve is furnished with each detector by means of which it is possible to set it to any frequency within its range.

If it were not possible to measure the frequency of the transponder after burial with the cache, it is still possible to locate it provided its original frequency in air was known.

a. At the suspected location of the transponder bury another transponder of about the same frequency to a depth of at least one foot. Measure the amount that the frequency has changed. Use this as a correction to the frequency of the transponder whose location is yet to be determined.

b. If the above is not feasible then it will be difficult to find the transponder. This difficulty is one of the security features of this system. The best course to follow is to lay out the area in 10 foot squares and at the center of each square stop and tune around the center frequency obtained from the table below:

If Transponder Frequency in air is	Tune Detector to:
80 to 85 kcs	0.2 kcs lower
85 to 90 kcs	0.3 kcs lower
90 to 95 kcs	0.4 kcs lower
95 to 100 kcs	0.5 kcs lower

II Maintenance

A. Trouble Shooting

If equipment fails to operate:

1. Check terminal voltages of batteries with equipment turned on.
2. Check oscillator output.
3. Check receiver input.
4. Check audio amplifiers.
5. Check output transformer and phones.

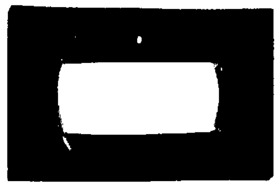
1. To check terminal voltages, remove the battery cover and turn equipment on. (The large coil does not need to be in the operating position to check the voltages.) Measure the voltages at the battery terminals with a voltmeter and replace weak batteries as follows: plate batteries, 100 V., filament batteries 1.0V. New batteries should be inserted and then tested also before

replacing battery cover. New battery voltage should change very very little between equipment off and on conditions.

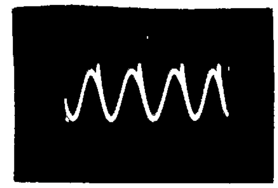
2. To check oscillator output, remove lead from J2 and connect a scope from J2 to the chassis. Waveform (a), Figure A, should be seen, after adjusting the scope, for proper operation. Amplitude of the signal should be approximately 0.75 V peak to peak. If no signal is observed check the oscillator tube V20 and its circuits if necessary. Resistance from high side of detector coil to ground should be about 70 ohms and cathode to ground about 25 ohms. (Chassis is ground). If waveform (b) is observed, check the neon tube V21 and its circuits.

3. To check receiver input the equipment must be in its operating position with both coil leads connected. The coil must be away from all metal objects or persons. Remove the front cover and connect the scope between T.P. and chassis. (Since there is a positive voltage of about 50 volts on T.P., it is necessary to use a capacitor input to scope). Adjust the scope sweep for several cycles and then the amplitude and fine tuning to get waveform (c). The fine tuning should be very sharp and the amplitude control should vary the amplitude of the spike. If no signal at all can be found check the coil L1 and the tuning section. Try several bands to be sure it is out on all bands. Resistance of L1 should be about 5.5 ohms. If no spike can be found with the adjustment of the controls check tube V1 and check to see if it has the proper operating voltages. If still no spike can be found, follow the alignment procedure.

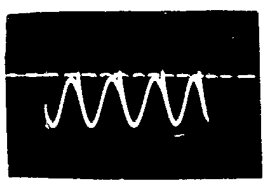
Waveform (a)



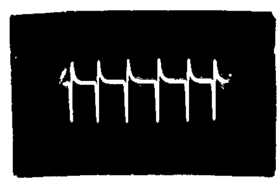
Waveform (b)



Waveform (c)



Waveform (d)



Waveform (e)

A
Figure ~~3.3.6.1~~

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4. Audio should be heard in the phones as the spike amplitude passes a minimum amplitude, as shown in waveform (d). If no audio is heard check tubes V2, V3, and V4, and then if necessary the receiver can be signal-traced with an audio oscillator through V2, V3, and V4. (be vareful to use a capacitor in the audio lead in order to keep from destroying the operating bias voltages. Bias for V4 is developed across R5 and C8 and should be about 17 volts. V2 and V3 have their grids returned to the cathode so they have no bias.) V4 is held below cutoff by the cathode bias and will not conduct until the positive peaks exceed the bias. Waveform on plate V4 should look like waveform (e).

5. If amplifiers work well then check the output transformer and phones if you still have no audio out.

B. Battery and Tube Replacement

The batteries and tubes of the detector are made accessible by removing the aluminum cover which is next to the plastic lid of the carrying case. When replacing the filament batteries, the polarity marked on the clips which hold the batteries should be observed and the batteries put in accordingly. Make certain that the ends of the clips press firmly against the batteries. The B batteries will only go in one way. Care should be taken to make sure that the snaps are closed tight. Burgess XX45 B batteries and 2R-A batteries are recommended when battery replacements are required.

To replace the tubes of the receiver circuit, the B batteries must be removed. The tube for the oscillator circuit is readily replaceable. The neon tube is soldered into the circuit but it should seldom need replacement. Tube V1 should have extremely high input impedance (grid to filament) If the input impedance is low the Q of the detector coil is greatly reduced. resulting in poor sensitivity or failure of operation. General Electric tubes were found to be superior to other types tested.

C. Alignment Procedure

An Oscilloscope, frequency meter (or signal generator) and insulated tuning wand are required.

1. General procedure

Remove the trimmer cover and set up the detector in operating position, making sure the detector coil is well clear of metallic objects. Set the fine tuning control to its mid-point and leave it there during the entire alignment. At all times when using the Test Point maintain the amplitude control at a setting which will keep the spike slightly higher than the peak of the sine wave, as shown in Figure A (d), or keep the audio level inthe phones at a comfortable operating level. Use fresh batteries and keep them off except while actually performing the alignment.

2. Oscillator Inductance

Oscillator inductance has been set and sealed so as to agree with the detector coil. No adjustments should be necessary.

3. Procedure for setting the oscillator to proper frequency coverage.

a. Set the band switch to Band #1.

b. Remove the coil lead from the oscillator output terminal J2 by pulling out the banana plug. Plug the oscilloscope test lead into its place.

c. If a frequency standard is available with a zero beat output circuit, connect it across the test lead and the chassis (this is across the oscillator output) and tune for a zero beat.

Note: The audio modulation will also be heard.

If the frequency standard (or calibrated signal generator) has sufficient output to drive the horizontal input of the oscilloscope connect it to the horizontal input and connect the vertical between the test lead and chassis. This will give a lissajour pattern. This procedure is preferred because the audio signal will not obscure the results.

d. Now set the main tuning control to 90 and the signal generator to 82 kcs.

e. Tune the oscillator trimmer for a zero beat.

f. Set the main tuning control to 8 and signal generator to 80 kcs.

g. Tune the oscillator padder for zero beat.

h. Repeat d, e, and f until no further adjustment is necessary.

i. Repeat the above procedure on each of the bands, working from #1 up to #10. Set high ends on 90 and low ends on 8 on the main tuning control. This will allow some overlap. Band #2 will cover 82-84 kcs, Band #3 will cover 84-86 kcs, etc. (Some bands may cover slightly more or less than 2 kcs but there should be no breaks in the coverage.)

j. Repeat the entire procedure to be certain that distributed capacity effects have not been reflected into bands previously adjusted.

4. <u>Procedure for setting receiver trimmers and padders.</u>

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This should not be done until the oscillator adjustment has been completed.

a. Replace coil lead in oscillator output. Remove and TURN OFF the signal generator. Connect oscilloscope to Test Point and adjust the sweep to get Figure A (d).

b. Set band switch to Band #10. Set main tuning control to 90.

c. Adjust receiver trimmer on Band #10 for maximum peak amplitude of the spike, turning down the amplitude as may be necessary.

d. Set Main tuning control to 8.

e. Adjust receiver padder on Band #10 for maximum peak amplitude of the spike as in c.

f. Repeat c, d, and e until no further adjustment is necessary.

g. Repeat above procedure for all bands (9 thru 1) and then repeat entire procedure until no further adjustment is necessary.

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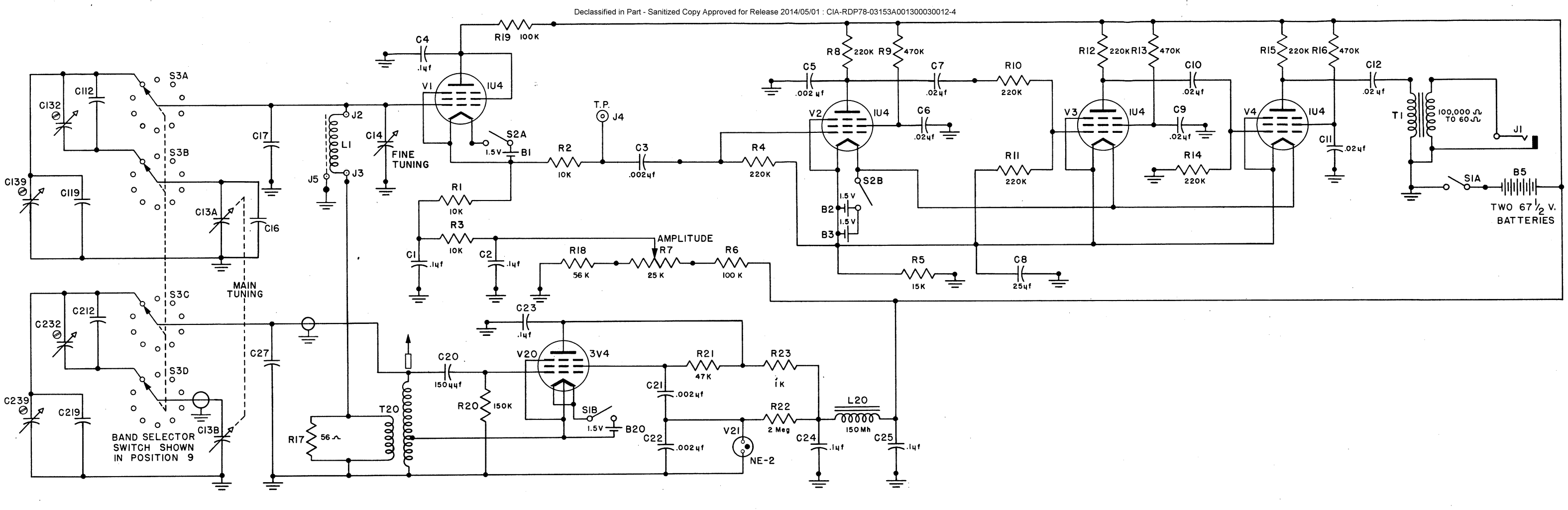
III. SCHEMATIC DIAGRAMS



CIRCUIT DIAGRAM OF DELTA-Q SYSTEM DETECTOR
FIGURE ~~3.3.2.2(e)~~ 3

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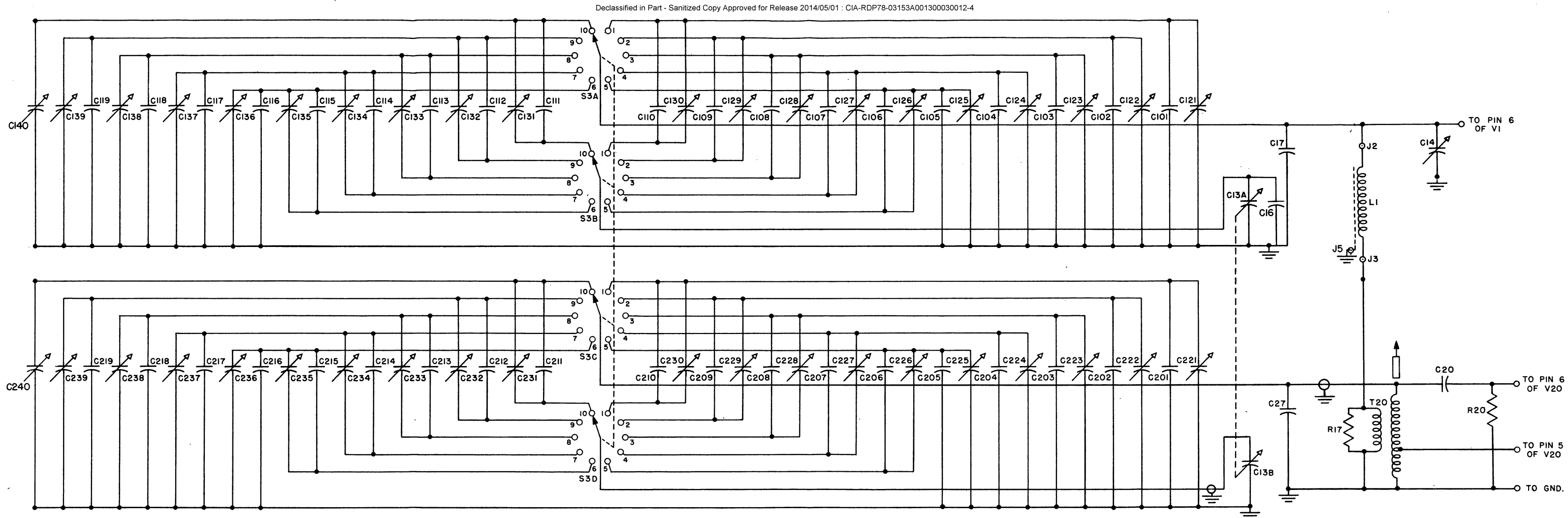

FIGURE ~~3.3.2.2(b)~~C BAND SWITCHING CIRCUITS

IV PARTS LIST

PARTS LIST

Part Number	Description	Manufacturer
R1, R2, R3	Resistor, 10,00 ohm ½ watt composition, ± 10% tolerance	Internationl Resistance Company
R4, R8, R10, R11, R12, R14, R15	Resistor, 220,000 ohm ½ watt composition, ± 10% tolerance	International Resistance Company
R19, R6	Resistor, 100,00 ohm ½ watt composition, ± 10% tolerance	International Resistance company
R5	Resistor, 15, 000 ohm ½ watt composition, ± 10% tolerance	International Resistance Company
R20	Resistor, 150,000 ohm ½ watt Composition, ± 10% tolerance	International Resistance Company
R7	Potentiometer, 25,000 ohm 2 watt molded composition, ± 10% tolerance Type AB	Ohmite Resistor Corp.
R9, R13, R16	Resistor, 470,000 ohm ½ watt composition, ± 10% tolerance	Internationl Resistance Company
R17	Resistor, .56 ohm ½ watt composition ± 5% tolerance	International Resistance Company
R18	Resistor, 56,000 ohm ½ watt composition, ± 5% Tolerance	International Resistance Company
R21	Resistor, 47,000 ohm ½ watt composition, ± 10% tolerance	International Resistance Company
R22	Resistor, 2.0 Megohm ½ watt composition, ± 10% tolerance	International Resistance Company
R23	Resistor, 1,000 ohm ½ watt composition, ± 10% tolerance	International Resistance Company
J1	Jack, audio output, Type A-1	P.R. Mallory & Co.
J2, J3, J4, J5	Jack, banana, hexed brass nickel plated, with recessed head #101	Herman H.Smith, Inc.
P2	Plug, banana, hexed brass nickel plated, molded plastic handle, red #212	Herman H. Smith, Inc.
P3, P5	Plug, banana, hexed brass nickel plated, molded plastic handle, black"212	Herman H. Smith Inc.

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Part Number	Description	Manufacturer
B1. B2, B3, B20	Battery, $1\frac{1}{2}$ volt, 2R radio"A" battery	Burgess Battery Co.
B5, B6	Battery, $67\frac{1}{2}$ volt, XX45 "B" battery	Burgess Battery Co.
C1, C2, C4, C23, C24, C25	Capacitor, .1 mfd, 300 vdc metalized paper	Tobe Deutschmann Corp.
C6, C7, C9, C10, C11, C12,	Capacitor, .02 mfd, 500 vdc disc ceramic	Aerovox Corporation
C3, C5, C21, C22	Capacitor, .002 mfd, 500 vdc disc ceramic	Aerovox Corporation
C8	Capacitor, 25 mfd, 25 vdc dry electrolytic	Sprague Products Co.
C13	Capacitor, variable air, 2 section ganged 15 to 62 mmfd	Variable Condenser Corporation
C14	Capacitor, variable air, single section #20025	James Millen Manufacturing Company
C121 to C140 C221 to C240	Capacitor, ceramicon trimmer, 7 to 45 mmfd, Type TS2A-7	Erie Resistor Corporation
C16	Capacitor, 24mmfd, silver mica, type CM-15	Arco Electronics Inc.
C17	Capacitor, 275mmfd, silver mica, type CM-15	Arco Electronics Inc.
C20, C102, C202	Capacitor, 150mmfd, silver mica, type CM-15	Arco Electronics Inc.
C27	Capacitor, 2.5 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C101, C201, C110, C210	Capacitor, 180 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C103, C203, C108, C208	Capacitor, 130 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C105, C205, C114, C214	Capacitor, 91 mmfd, silver mica type CM-15	Arco Electronics Inc.

Part Number	Description	Manufacturer
C104, C204, C106, C206	Capacitor, 110 mmfd, silver mica, Type CM-15	Arco Electronics Inc.
C107, C207	Capacitor, 120 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C109, C209	Capacitor, 160 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C111, C211, C117, C217	Capacitor, 56 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C112, C212	Capacitor, 62 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C113, C213, C116, C216	Capacitor, 75 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C115, C215	Capacitor, 100 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C118, C218	Capacitor, 39 mmfd, silver mica, type CM-15	Arco Electronics Inc.
C119, C219	Capacitor, 20 mmfd, silver mica, type CM-15	Arco Electronics Inc.
L1	Coil, detection, 100 turns, #50-38, single nylon Litz wire in 3 layers on plexiglas form, with Faraday shield	ERA
L20	Choke, 150 mh, unshielded iron core, 100 ma, DCres., 268 ohm, Type BC-535	Merit
T20	Transformer, oscillator, primary constructed with 3 coil sections from 10 mh RF choke (National R100-S) mounted on CTC LS-6 form, secondary consists of 7½ turns of #22 single strand tinned wire wound on composition bakelite coil from 3/4" D x 7/8"	ERA
T1	Transformer, impedance matching, 100,000 ohm to 60 ohm, primary resistance 4700 ohm, secondary resistance 3.3 ohm, Type SSO-6	United Transformer Company

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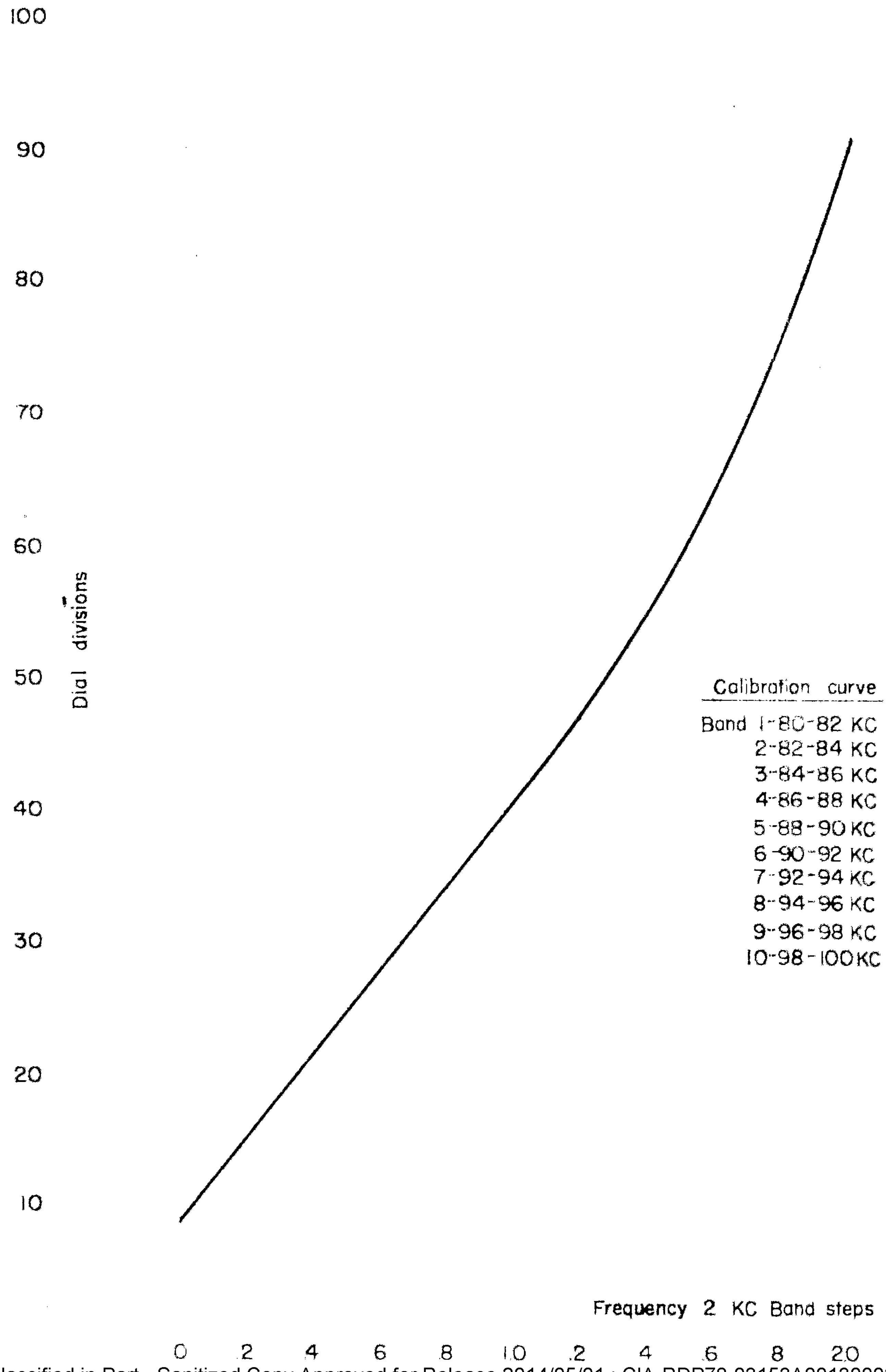
Part Number	Description	Manufacturer
S1, S2	Switch, toggle, DPST, # 81024	United Transformer Company
S3	Switch, grayhill, Series 24, rotary, six deck, ten position multideck, miniature tap switch	Grayhill
X20, X1, X2, X3, X4	Socket, 7 pin miniature mica filled bakelite with tube shield base	Cinch-Jones
V20	Tube, 3V4	General Electric
V1, V2, V3, V4	Tube, 1U4	General Electric
V21	Tube, NE-2, neon	General Electric
E7, E8, E9, E10, E11	Shield, tube for miniature 7 pin tube	Cinch-Jones
SP1	Headphones, telex monoset, stetho-scope design, 500 ohm impedance	Telex Electro-Acoustic Division

V CALIBRATION CURVE


100
90
80
70
60
50
40
30
20
10
Dial divisions
Calibration curve
Band 1-80-82 KC
2-82-84 KC
3-84-86 KC
4-86-88 KC
5-88-90 KC
6-90-92 KC
7-92-94 KC
8-94-96 KC
9-96-98 KC
10-98-100 KC
Frequency 2 KC Band steps
0 .2 .4 .6 .8 1.0 .2 .4 .6 .8 2.0